
The vanishing hand: the changing dynamics of industrial capitalism

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Alfred Chandler's portrayal of the managerial revolution of the late nineteenth and early twentieth centuries does not extend well into the late twentieth century, when widespread vertical disintegration began replacing the classical multi-unit managerial enterprise. This paper attempts to explain the new economy in a manner consistent with Chandler by providing an enlarged theoretical account of industrial evolution. In this account, clusters of Chandlerian firms appeared as a temporary episode within a larger Smithian process of the division of labor.

1. Introduction

In *The Visible Hand* (1977) and subsequent works,¹ Alfred Chandler focused the spotlight on the large, vertically integrated corporation. He did this not merely to chronicle the rise of that institution but also to explain it and to give it a prominent place in US economic growth during the last century and a half. The force and originality of Chandler's ideas coalesce in the book's title, a provocation in the direction of Adam Smith (1976). Smith had predicted an increasingly fine division of labor as the response to a growing extent of the market; and, although he was actually quite vague on the organizational consequences of the division of labor, Smith was clear in his insistence on the power of the invisible hand of markets to coordinate economic activity.² Chandler's account appears to challenge this prediction: internal organization and managerial authority became necessary to coordinate the industrial economy of the late nineteenth and early twentieth centuries. The visible hand of managerial coordination had replaced the invisible hand of the market.

On one reading, *The Visible Hand* is about the response of business institutions to the conditions of a particular historical episode, namely the dramatic increases in

¹Notably *Scale and Scope* (1990).

²In what follows, I will often appear to conform to the now rather outdated distinction between markets and hierarchies, as that seems the best idiom in which to engage the issues as Chandler raises them. Nonetheless, I hope that the narrative will convey, perhaps subtly, my belief that 'the market' encompasses a wide range of forms many of which are not anonymous spot contracts but rather have 'firm-like' characteristics of duration, trust, and the transfer of rich information. See Lamoreaux *et al.* (2002) for a discussion arguing that it is valuable to distinguish these two classes. For an extensive discussion of 'network' forms of organization, see also Langlois and Robertson (1995).

population and per capita income in the United States after the Civil War, coupled with the equally dramatic fall in transportation and transaction costs attendant on the railroad, the inland water network and the telegraph. On another reading, however, the managerial revolution represents the emergence of an institutional structure inherently superior for all times and places to that of decentralized ownership and market exchange in all its forms. History is never kind to historicists, however; and the facts of the last quarter century have made life uncomfortable for those who would project the Chandlerian model into the present. It has become exceedingly clear that the late twentieth (and now early twenty-first) centuries are witnessing a revolution at least as important as, but quite different from, the one Chandler described. Strikingly, the animating principle of this new revolution is precisely an *unmaking* of Chandler's revolution. Rather than seeing the continued dominance of multi-unit firms in which managerial control spans a large number of vertical stages, we are seeing a dramatic increase in vertical specialization—a thoroughgoing 'de-verticalization' that is affecting the traditional Chandlerian industries as much as the high-tech firms of the late twentieth century. In this respect, the visible hand—understood as managerial coordination of multiple stages of production within a corporate framework—is fading into a ghostly translucence.

We are left with the choice of abandoning Chandler or reinterpreting him. This essay takes the latter course. If we take the first reading of *The Visible Hand*—that the managerial revolution was an adaptation to particular historical circumstances—then we can explain the organizational revolution of the new economy by embedding Chandler's story within a roomier account that admits of a range of possible historical circumstances. As a byproduct, such a reinterpretation can hope not only to explain the new economy but also to shed light on the organizational changes of the original Chandlerian revolution.

The basic argument—the vanishing-hand hypothesis—is as follows. Driven by increases in population and income and by the reduction of technological and legal barriers to trade, the Smithian process of the division of labor always tends to lead to finer specialization of function and increased coordination through markets, much as Allyn Young (1928) claimed long ago. But the components of that process—technology, organization and institutions—change at different rates. The managerial revolution Chandler chronicles was the result of such an imbalance, in this case between the coordination needs of high-throughput technologies and the abilities of contemporary markets and contemporary institutions to meet those needs. It was an organizational solution appropriate to its time and place. But with further growth in the extent of the market and the evolution of institutions to support exchange, the central management of vertically integrated production stages is increasingly succumbing to the forces of specialization.

Notice that this is not an argument that managerial coordination will vanish entirely from the scene and that the large vertically integrated corporation will follow the buggy whip and the vacuum tube into oblivion. Rather, it is an argument that, in a population

sense, large vertically integrated firms are becoming less significant and are joining a richer mix of organizational forms. Many commentators on Chandler have long insisted on the importance of small firms and flexible production in economic growth, even during the managerial revolution (Atack, 1986; Supple, 1991; Scranton, 1997). But Chandler is right to point out both the novelty and the ‘clustering’ of large multi-unit enterprises during the late nineteenth and early twentieth centuries. My argument is that, in the late twentieth century, the factors that led to such clusters disappeared: multi-unit enterprises remain part of the landscape, and will continue to arise when circumstances dictate.³ But they are an increasingly small part of a landscape that features a wide variety of market and network forms. Moreover, with growth in the extent of the market and the evolution of market-supporting institutions, the *average* multi-unit enterprise today is less vertically integrated than its counterpart in the Chandlerian era.

My argument takes as its primary analytical lens not the mainstream economics of organization (Williamson, 1985; Milgrom and Roberts, 1992) but rather an evolutionary capabilities approach (Langlois and Robertson, 1995). In this respect, my account stays true to Chandler even while placing him in a larger frame. As in Chandler, secular changes in relative prices attendant on ‘globalization’ (driven by technology or politics) affect economic organization not only directly but also, and perhaps more importantly, indirectly through changes in technology. Production costs matter as much as transaction costs (Langlois and Foss, 1999). Moreover, the kind of transaction costs that matter in history are often not those of the Williamson kind but those I have labeled *dynamic transaction costs* (Langlois, 1992b). Costs of coordinating through markets may be high simply because existing markets—or, more correctly, existing market-supporting institutions—are inadequate to the needs of new technology and of new profit opportunities. But when markets are given time and a larger extent, they tend to ‘catch up,’ and it starts to pay to delegate more and more activities rather than to direct them administratively within a corporate structure.⁴

2. The evolutionary design problem

Industrial structure, then, is really about two interrelated but conceptually distinct systems: the technology of production and the organizational structure that directs production. These systems jointly must solve the problem of *value*: how to deliver the

³For example, in the 1980s, when vertical unbundling was the rule of the day, Nicolas Hayek was busy creating a Chandlerian corporation out of the remnants of the fragmented Swiss watch industry (Langlois, 1998). He needed to rearrange capabilities in a systemic way—and to do it quickly—in the face of creative destruction wrought by the Japanese development of electronic watch movements, which had rendered obsolete existing Swiss capabilities in mechanical movements. Centralized ownership and control was the most effective way to bring about the necessary reorganization.

⁴Far from being inherently superior, managerial hierarchies—like most organizational structures—are a second-best solution that emerges in want of better alternatives.

most utility to ultimate consumers at the lowest cost. Industrial structure is an evolutionary design problem. It is also a continually changing problem, one continually posed in new ways by factors like population, real income, and the changing technology of production and transaction. It was one of the founding insights of transaction-cost economics that the technological system does not fully determine the organizational system (Williamson, 1975). Organizations—*governance structures*—bring with them their own costs, which need to be taken into account. But technology clearly *affects* organization. This is Chandler's claim. The large-scale, high-throughput technology of the nineteenth century 'required' vertical integration and conscious managerial attention. In order to explicate this claim, we need to explore the nature of the evolutionary design problem that industrial structure must solve.

Like a biological organism, an organization confronts an environment that is changing, variable and uncertain. To survive and prosper, the organization must perceive and interpret a variety of signals from the environment and adjust its conduct in light of those signals. In short, organizations are information-processing systems. This is no less true of early nineteenth-century production networks than it is of an Internet-enabled firm of today: in a real sense, the economy has long been a knowledge economy. Also like biological organisms, business organizations differ in the mechanisms they use to process information and to deal with variation and uncertainty. Nonetheless, as James Thompson (1967: 20) argued, all organizations respond to a changing environment by seeking to 'buffer environmental influences by surrounding their technical cores with input and output components'. Understanding the ways in which organizations *buffer* uncertainty is thus crucial to understanding organizational structure.

In Thompson's discussion, buffers seem to take many forms. The 'input and output components' he refers to are various kinds of shock-absorbers mediating between a highly variable environment and a more predictable production process. Inventories are a classic example: they can ebb and swell with changes in demand or supply while allowing a smooth flow of product. But Thompson also mentions preventive maintenance, which reduces the number of unplanned outages, as well as the training or indoctrination of personnel, which reduces variability in human performance.

Arthur Stinchcombe (1990) has picked up the human-performance thread and pulled it in a more useful direction. In his interpretation, a skilled human is an information-processing system that can serve as an important element in the process of buffering uncertainty. Human cognition can often interpret the data from a complex environment and translate that data into the kinds of predictable or routine information the productive system can use. For example, a professor translates the complex information on an essay exam into a letter grade that the Registrar's office can process; a physician translates the complex inputs from observation and medical instrumentation into a diagnosis, which results in a relatively unambiguous set of instructions for nurses, pharmacists, patients, etc. (Stinchcombe, 1990: ch. 2). Business people serve a similar function. They translate complex data from the economic environment into a more-

or-less predictable flow of outputs—contracts signed, products delivered, etc. We might even go so far as to associate the buffering role that human cognition plays in business with the very idea of *management*.

Levinthal and March (1993: 98) add a perspective on buffering that is relevant to my argument. They associate Thompson's notion with the late Herbert Simon's (1962) well-known analysis of system decomposition. A *decomposable system* is one that is cut into pieces or 'modularized' in such a way that most interactions (which we can think of as flows of information) take place within the modules; interactions among modules are kept to a minimum and are regularized through formal 'interfaces'.⁵ One of the prime benefits of decomposability, in Simon's view, is that it allows for greater stability in the face of environmental uncertainty: a single piece can be altered, replaced or even destroyed without threatening the survival of the whole. This is already a kind of buffering. Levinthal and March point out that decomposition entails (or at least allows) 'loose coupling' between organizational units, which effectively simplifies the information-processing problem the organization faces. Each department can concentrate on the local consequences of the information it receives from the environment without having to contemplate the global implications. Computer scientists would call this distributed processing. And economists would recognize the argument as akin to F. A. Hayek's (1945) famous account of the price system as a well-decomposed information-processing system. Indeed, I will suggest before long that the decomposition of organization into market can sometimes confer additional buffering benefits well known to economists, notably the ability to spread risks.

In what follows, I trace the history of how organization in the United States has confronted its evolutionary design problem over the last two centuries. The underlying process, I argue, is the Smithian one of specialization and differentiation of function. But, as expanding markets and technological change altered the economic environment, so were altered the buffering problems industry faced. The managerial revolution of the nineteenth century was one solution to the buffering problem, appropriate to its time and place. But it is by no means the only solution industry has found; and it is certainly not the approach toward which the new economy is gravitating.

3. Antebellum organization

Along one dimension, the US system of production and distribution in the early years of the nineteenth century was indeed coordinated by the invisible hand of the market. The high cost of inland transportation created many isolated local markets, leading to a fragmented and decentralized system of production and distribution.⁶ To the extent

⁵A perfectly decomposable system is one in which *all* interactions are kept within the subsystems. In reality, however, the best we can probably hope for is a system that is *nearly decomposable*. For a further discussion of these ideas and of the theory of modular systems more generally, see Langlois (2002).

⁶The main constraint, of course, was the capacity of horse-drawn wagons and the sorry state of the

that it was possible to aggregate demands, it was the independent merchant or middleman who did so.

Looked at in another way, however, the antebellum value chain reflected a low level of specialization, just as one would expect in a thinly populated country with poorly integrated regional markets. The focus of the economy was not on manufacturing, which was still a matter of local crafts production, but rather on trade. And the central actors were the all-purpose generalist merchants. Merchants always specialized on those margins where specialization made economic sense; but there were relatively few such margins in the antebellum period. Thus, rather than concentrating on a narrow range of commodities or on a single aspect of trade, merchants tended to diversify fairly widely; and they acquired a wide range of skills necessary to trade.⁷ The merchants were generalists, of course, because the volume of trade was too small to support specialization. Only by aggregating demands for a variety of types of goods could they generate sufficient scale to employ their overhead resources adequately. This meant in addition that marketing techniques, and in many cases the goods themselves, remained 'generic' or non-specialized in order to permit the necessary diversification.

Since the antebellum industrial system relied heavily on markets to coordinate among stages of production and distribution, there was a certain amount of 'loose coupling' that helped to buffer variation. Inventories were no doubt in widespread use. More generally, the system employed as a buffering mechanism what Jay Galbraith (1973: 22ff.) called 'slack resources': the antebellum economy was not a fast-paced, high-throughput system. But it is also important to notice that, because the system reflected a relatively low level of division of labor in the Smithian sense, much of the coupling, loose or otherwise, was effected by human cognition. Each stage of production encompassed many sub-stages that a larger extent of the market might have transformed into specialties. As a result, buffering by skilled humans played an important role. In crafts production, for example, both parts and finished products could exhibit considerable variation because the artisan, who personally undertook all or most stages of production, was able to buffer the variation in the parts and the variation in the tastes of consumers. Wielding a wide repertoire of skills in a flexible way (Leijonhufvud, 1986), a crafts artisan can translate complex information about tastes and technology into a working finished product.

network of dirt roads. Indeed, as late as the early twentieth century, 'economists estimated that it cost more to haul a bushel of wheat along ten miles of American dirt road than it did to ship it across the ocean from New York to Liverpool' (Gladwell, 2001: 13).

⁷The merchants' strength rested not so much on their mastery of the ancillary techniques of shipping, insurance, finance, and the like, as on their ability to use them in support of the fundamental trading function, buying and selling at a profit. The merchants exercised this function over a range of goods as varied as the commercial techniques they employed. The histories of individual firms, as well as merchants' advertisements in colonial and early national period newspapers, demonstrate the merchants' willingness to sell anything that offered a profit. Coffee, sugar, iron, cloth—all were grist for the merchants' mills' (Porter and Livesay, 1971: 17).

The most important buffers in the antebellum period (and indeed for centuries before that) were the generalist merchants. It was they who in effect *provided* the (loose) coupling within the market economy. Despite the recurrent features of trading in otherwise diverse goods, the thinness of antebellum markets confronted these merchants with a wide variety of concrete circumstances and special problems to solve on a daily basis. Like crafts artisans, they needed to integrate a wide variety of tasks and process a wide range of signals from the environment. What enabled them to solve these complex information-processing problems was the width of their sets of skills and their flexibility in matching skills to problems (Stinchcombe, 1990: 33–38). They noticed profit opportunities and solved a myriad practical problems in a way that resulted in the more-or-less smooth delivery of goods and services. In the low-fixed-cost economy of the period, profitability depended not on the ownership of tangible assets but on specialized knowledge and the ability to adapt.

In the years after 1815, population growth, geographical expansion and international trade (especially in cotton) combined to increase the extent of the market in a classic Smithian way: by an increase in the volume of goods traded but without much change in the nature of those goods (Porter and Livesay, 1971: 17). And, as one would predict, merchants began to specialize to a somewhat greater extent by commodity or function, almost always by means of specialized firms rather than through intra-firm specialization.

But merchants were far from completely specialized. Importantly, many merchants combined the middleman function with a financial function, something that was crucial for the development of US manufacturing before the Civil War (Porter and Livesay, 1971: 71ff.). As America began industrializing, the manufacturing sector was chronically undercapitalized, especially with respect to working capital. Investment is always a difficult business because of the problem of asymmetric information: the borrower typically has better information about his or her prospects than does the lender. In the absence of institutions designed to reduce these ‘agency costs’, lenders will be reluctant to part with their money unless they have good information about the borrower and can cheaply monitor the use of the funds. Many firms in the metals and mechanical trades were forced to rely on the private funds of the owner-manager or on retained earnings. Increasingly, however, merchants became an important source of financing. Since they dealt regularly with the manufacturers, they had knowledge of their operations and could observe the use of funds lent.⁸ To the extent that banks of the period helped finance industrial development, they did so not as arm’s-length lenders but as inside lenders to the networks of merchants and manufacturers who were their principal stockholders.⁹ We can understand this as an instance of using human

⁸For example, the merchant James Laughlin bankrolled the Jones and Lauth iron works, which prospered to become the Jones and Laughlin Steel Corporation (Porter and Livesay, 1971: 67).

⁹As Naomi Lamoreaux (1986: 659) has shown in the case of New England, the function of banks in this era ‘was to serve as the financial arms of the extended kinship groups that dominated the economy. As

information processing as a ‘buffer’ on the financial side: closely observing production, or even taking a hand in directing it, is a way of managing the uncertainty of capital provision.

Thus the ‘value chain’ in the US in the early years of the nineteenth century was one dominated by merchant middlemen, who lowered transaction and agency costs by aggregating outputs and demands from widely dispersed producers and consumers as well as providing capital for the growth of manufacturing.

4. The managerial revolution

Is change ultimately a gradual process or is it one that operates through discontinuous jumps or revolutions? This is one of the hoary questions of economic history—and, indeed, of social theory more generally. One’s answer to the question is almost always a matter of perspective. From one viewpoint, for example, the coming of the railroad and telegraph by the time of the Civil War was merely the continuation of a process of decreasing transportation costs already in motion. By 1857, one could travel about twice as far from New York in a day as had been possible in 1830. But the same could be said of the change between 1800 and 1830 (Paullin, 1932: plate 138). From another viewpoint, however, the railroad and telegraph had a profound and discontinuous effect on the organization of production and distribution in the United States.

The important consequence of the lowering of transportation and communications costs, of course, was the collapse of geographical barriers and the increasing integration of the domestic market.¹⁰ In effect, nineteenth-century technical change in transportation and communication brought about an all-American version of ‘globalization’, a topic to which we will return. Larger markets made it possible to adopt new techniques in many transformational and distributional stages in order to take advantage of economies of scale.¹¹ With larger markets to serve, it became economical to reorganize

such, banks provided kinship groups with a stable institutional base from which to raise the capital consumed by their diverse business enterprises. Like their modern counterparts, then, early banks tapped the savings of the surrounding community, but they did so mainly selling shares of stock, not by attracting deposits. This too was an important difference. It meant that these early institutions functioned less like modern commercial banks and more like investment pools through which outsiders could participate in the kinship groups’ diverse enterprises.’ The function of banks may have differed somewhat in the South and Mid Atlantic States (Bodenhorn, 2000), but the standardization of lending into specialized banks had to await thicker markets.

¹⁰Some numbers: between 1869 and 1902, the cost of shipping a quarter of wheat from Chicago to New York by lake and rail fell by 72 per cent; the cost of shipping the same quarter by rail alone fell 71 per cent (Findlay and O’Rourke, 2002: 31). Between 1870 and 1910, the price spread for wheat between New York City and Iowa fell from 69 to 19 per cent; between New York and Wisconsin it fell from 52 to 10 per cent (Williamson, 1974: 259).

¹¹This is not to say that the rise of large establishments and mass production obliterated specialty producers or the market economy. Small-scale, flexible production grew alongside the large firms, provided those firms with many needed inputs and contributed importantly to economic growth

some stages using a finer and more coordinated division of labor, what Leijonhufvud (1986) calls 'factory production.' It also became economical to use larger and more durable machines that were often capable of integrating multiple stages of production.¹² In both cases, larger markets allowed a shift to higher-fixed-cost methods, which were capable of lowering unit costs—often dramatically—at high levels of output.

All of this altered the value chain in two ways. First, it reduced the number of establishments necessary at some transformation and distribution stages. When market size permits economies of scale, a few large plants can operate more cheaply—often far more cheaply—than a larger number of small plants. As Chandler tells the tale, consolidation often played out through a set of typical episodes. First came the cartel, in which previously insulated competitors, having suddenly found themselves operating in the same large market, attempted to manage the allocation of output. Predictably, this met with little success, which prompted the formation of a holding company. By pooling ownership in a single meta-company, in which each individual owner would take a share, the holding company transformed an incentive to cheat on the cartel into an incentive to maximize total capital value. The unintended consequence of this, however, was that the holding company took on a life of its own. Especially as the original owners died out or cashed out, the head office began managing production and investment in increasingly coherent ways, normally with a view to consolidating production in the larger and more efficient plants. The culmination of this was the multidivisional (M-Form) corporation in the twentieth century, in which the old structure of many identical independent producers had been transmogrified into a unified structure with a wholly new functional division of administrative responsibility. Not all cases followed this model, of course. In fields with few incumbent producers, large unified firms grew up more or less directly.

The position of the middleman in the value chain also changed dramatically. As transformation and distribution stages grew in size and shrank in numbers, independent wholesalers were increasingly replaced by in-house purchasing and marketing units. This was so for two reasons. First, the demands of the high-throughput producers began reaching and exceeding the capacities of the middlemen, thus eliminating one of the primary *raisons d'être* of wholesalers, the ability to work at higher volumes than one's customers¹³ (Chandler, 1990: 29). Second, standardization of inputs and outputs militated against another of the merchant's comparative advantages, the ability to deal with a diverse set of products (Porter and Livesay, 1971). In some cases, like petroleum,

(Atack, 1986; Supple, 1991; Scranton, 1997). Nonetheless, the multi-unit mass-producers represented an important new element to industrial structure, one calling out for economic explanation.

¹²I distinguish these two results of the increasing extent of the market as the *division-of-labor effect* and the *volume effect* (Langlois 1999a,b).

¹³As John D. Rockefeller said of Standard Oil, 'we had to create selling methods far in advance of what then existed; we had to dispose of two, or three, or four gallons of oil where one had been sold before, and we could not rely upon the usual trade channels then existing to accomplish this' (quoted in Chernow, 1998: 252).

producers integrated all the way from raw materials to the final consumer (McLean and Haigh, 1954).

Chandler stresses the ways in which this process differed from what the Smithian division of labor would have predicted; that is, he focuses on the ways in which integration bypassed market relations among previously distinct stages. But it is important to notice that, however visible the hand of management had become, the process Chandler describes is at one level a fundamentally Smithian one. The rise of the modern corporation is very much about increased specialization of function. In an owner-managed firm, management is a craft engaged in by amateurs; in the modern corporation, management is a profession.¹⁴ Moreover, the multidivisional structure that modern corporations came to adopt in the twentieth century reflects a decoupling of the strategic functions from the day-to-day functions of management in order to cope with the greater demands on managerial attention¹⁵ (Williamson, 1985: 279–283).

The clearest and most significant way in which the rise of the modern corporation reflects specialization and division of labor, of course, is on the financial side. The corporation evolved in conjunction with developments in securities markets throughout the late nineteenth and early twentieth centuries (and, as we'll see, beyond). These developments encouraged the separation of ownership from control by creating alienable securities that could be traded on increasingly liquid markets. What made such markets possible was the development of social institutions like the limited liability corporation as well as standardized techniques for accounting and financial reporting. These latter made it easier for investors to ascertain the value of securities without detailed knowledge of the business or geographic proximity to it, thus somewhat attenuating the costs of asymmetric information (Baskin, 1988: 227–230). By reducing the entry requirements to capital supply and by permitting unprecedented opportunities for risk diversification, the development of anonymous securities markets lowered the costs of capital for high-throughput projects and allowed managers to lay off some of the risks—that is, the financial risks—on anonymous markets (Jensen and Meckling, 1976). In effect, then, the function of 'buffering' financial uncertainties

¹⁴Take note that, although specialized to management, the manager was a generalist along another important direction: the manager was skilled in general techniques of management independent of any specific firm or industry. I return to this point below.

¹⁵In Chandler's eyes, this progressive specialization and separation of function during the rise of the large corporation is indeed a large part of the secret of that system's success. He blames what he perceives to be Britain's lag behind the US and Germany on precisely the British inability to specialize. 'In most British enterprises senior executives worked closely in the same office building, located in or near the largest plant, having almost daily personal contact with, and thus directly supervising, middle and often lower-level managers. Such enterprises had no need for the detailed organization charts and manuals that had come into common use in large American and German firms before 1914. In these British companies, selection to senior positions and to the board depended as much on personal ties as on managerial competence. The founders and their heirs continued to have a significant influence on top-level decision-making even after their holdings in the enterprise were diminished' (Chandler, 1990: 242).

was transferred in part from human information processors—generalist managers—to external market institutions armed with the buffering mechanism of portfolio diversification.

Nonetheless, as Chandler insists, along another dimension the rise of the large corporation reflected a process of *reduced* specialization. Whereas distinct sets of managers had once supervised each stage of production, with only the market standing above them, in the era of the large corporation a single set of managers came to supervise multiple stages of production. At the operational level, of course, the division of labor did not necessarily decrease and may have increased. Each subunit of the large corporation had its specialized managers, the counterparts to the managers of the previously distinct stages. Integration of the management function took place at a ‘corporate’ level higher than the day-to-day managers. The head office oversaw multiple stages of production in much the way a crafts artisan may have overseen multiple stages in the making of an artifact.

Why integration? I have long argued that one cannot explain organizational structures without looking at the dynamic processes in which they are created (Langlois, 1984). In my view, centralized organization often supplants more decentralized organization when technological and market opportunities call for a systemic reorganization of the structure of production and distribution. This is so for the same reason that decision-making becomes more centralized during a war or other crisis. When many different pieces of the system must be changed simultaneously to create new value, centralized control can often help overcome the narrow visions of the local participants, and centralized ownership can more easily trump the vested interests of those participants (Langlois, 1988; Bolton and Farrell, 1990). In short, vertical integration often occurs when it can overcome the *dynamic transaction costs* of systemic change (Langlois, 1992b).

In many of the nineteenth-century industries Chandler chronicles, the possibilities of economies of scale at various transformation stages called for systemic reorganization in other complementary parts of the system. Consider the story of refrigerated meatpacking (Chandler: 1977: 299 ff.; Porter and Livesay, 1971: 168–173; Fields, 2003). In the 1870s, the developing railroad network had permitted the shipment of western meat on the hoof to eastern markets, thus taking advantage of economies of scale in western pasturing. But further economies of scale were possible, and Gustavus Swift realized that, if the system of meat packing, shipping and distribution were completely redesigned, it would be possible to reduce transportation costs and to take advantage of a number of scale economies, including those of a ‘disassembly line’ in a high-throughput slaughterhouse. Claiming these economies required changing complementary assets and capabilities throughout the system, including the development and production of refrigerated railcars and the establishment of a nationwide network of properly equipped branch houses to store and merchandise the meat. Swift found it more economical to integrate into many of these complementary stages than to face the dynamic transaction costs of persuading the various asset owners to cooperate with

him through the market.¹⁶ As Porter and Livesay (1971: 171) argue, the development of an integrated (non-independent) system of branch houses was ‘a response to the inadequacies of the existing jobber system’.

But explaining the origins of vertical integration (or any other structure of organization) does not necessarily explain why that structure persists. If integration is temporarily necessary but otherwise grossly inefficient, we would expect the integration to be undone over time. And there are certainly examples of this.¹⁷ But it is also possible that a structure of organization can persist because of ‘path dependence’. A structure can be self-reinforcing in ways that make it difficult to switch to other structures. For

¹⁶Raff and Temin (1991) have attempted to interpret this episode within the strict confines of the doctrine of asset specificity (Klein *et al.*, 1978). According to this doctrine, which has arguably become the dominant explanation of vertical integration in the literature of academic economics, cooperating parties are impelled to merge their operations when one or both hold assets highly specific to the transaction they contemplate. This is because in a market setting one of the parties could threaten the other with ‘hold-up’, thus putting the specific assets at risk. Raff and Temin make an excellent case. But the case they make is mine. They claim that Swift integrated widely because (and only because) all of the assets he came to own were transaction specific and would have put him at risk of expropriation had he left them in the hands of others. Some of the assets involved—railroad cars, maybe—might fit this profile. But many other things Swift bought—like ice—were clearly generic commodities obtainable in thick markets. Raff and Temin try to explain this away: ‘But Swift could not rely on independent suppliers to provide ice at the time and place he needed. And the cost to him of being without ice at that time and place was very great. . . . Swift could be held up by the owner of an icehouse who had the only ice in the neighborhood’ (Raff and Temin, 1991: 25). But this won’t do. The theory of asset specificity is an equilibrium proposition. In equilibrium, no ice-house master could have threatened to hold Swift up, since Swift had a credible threat to replace his custom, and none of Swift’s assets would depreciate in equilibrium as a result. Of course, Swift cared not a wit about equilibrium. He was worried about all interruptions in service, which—and here is the point—could happen for many reasons in addition to hold-up threats. The ice-house owner could simply be incompetent, or he could have a bad hair day. (Or Swift had acquired superior capabilities for managing the movement of ice to refrigerated cars because he had specialized in that business, and it was more costly for him to transfer that knowledge to others than to integrate.) Even if the owner is guileless and well intentioned, the high-throughput system would be at risk. Nor does it help to say that, although non-specific in any ordinary sense, the ice had the character of time specificity or location specificity. Apart from forcing the notion of asset specificity to dance on the head of a pin, this ignores the fact that the costs of time and location specificity—what I call dynamic transaction costs (Langlois, 1992b)—do not depend on the threat of holdup but can arise from a multitude of causes. The threat of hold-up in the face of specific assets is but a small subset of the much wider problems of buffering that managers of high-throughput systems face.

¹⁷As Chandler (1992: 88–89) notes: ‘integration . . . should be seen in terms of the enterprise’s specific capabilities and needs at the time of the transaction. For example, Williamson (1985, p. 119) notes that: “Manufacturers appear sometimes to have operated on the mistaken premise that more integration is always preferable to less.” He considers backward integration at Pabst Brewing, Singer Sewing Machine, McCormack [*sic*] Harvester, and Ford “from a transaction cost point of view would appear to be mistakes”. But when those companies actually made this investment, the supply network was unable to provide the steady flow of a wide variety of new, highly specialized goods essential to ensure the cost advantages of scale. As their industries grew and especially as the demand for replacement parts and accessories expanded, so too did the number of suppliers who had acquired the necessary capabilities.’

example, the nature of learning within a vertically integrated structure may reinforce integration, since learning about how to make that structure work may be favored over learning about alternative structures.¹⁸ A structure may also persist simply because the environment in which it operates is not rigorous enough to demand change. And organizations can sometimes influence their environments—by soliciting government regulation, for instance—in ways that reduce competitive rigors.

In the end, however, structures that persist for significant amounts of time may indeed do so because they solve the design problem well—or at least well enough.¹⁹ Surely this is Chandler's claim: the large vertically integrated managerial corporation persisted because it was the appropriate solution for the design problem of its day. Reading Chandler and his interpreters, we can discern the outlines of that solution.

At the price of high fixed costs, one could create low average costs—at least so long as one could reliably utilize the fixed assets to capacity.

In the capital-intensive industries the throughput needed to maintain minimum efficient scale requires careful coordination not only of the flow through the processes of production but also of the flow of inputs from suppliers and the flow of outputs to intermediaries and final users.

Such coordination did not, and indeed could not, happen automatically. It demanded the constant attention of a managerial team or hierarchy. The potential economies of scale and scope, as measured by rated capacity, are the physical characteristics of the production facilities. The actual economies of scale or of scope, as determined by throughput, are organizational. Such economies depend on knowledge, skill, experience, and teamwork—on the organized human capabilities essential to exploit the potential of technological processes. (Chandler, 1990: 24)

In a world of decentralized production, most costs are variable costs; so, when variations or interruptions in product flow interfere with output, costs decline more or less in line with revenues. But when high-throughput production is accomplished by means of high-fixed-cost machinery and organization, variations and interruptions leave significant overheads uncovered. Chandler would say that uncontrolled variation in work flows lowers the effective economies of scale available. Integration and management are an attempt to control—to *buffer*—product-flow uncertainty.

Employing a finely sliced division of labor or large integrated machines or both, traditional mass production always requires the elimination of variation between stages of production. Although never fully realized until the day in 1908, when three of Henry Leland's Cadillacs emerged perfect from a heap of scrambled parts in Brooklands,

¹⁸See Langlois and Robertson (1989: 367–368) for an example from the early years of the Ford Motor Company.

¹⁹Biologists understand that, to avoid a tautological theory, evolutionary explanation must mean showing how the biological structure in question would meet 'an engineer's criterion of good design' (Gould, 1977: 42).

Surrey,²⁰ the promise of interchangeable parts had animated the quest for mass production throughout the nineteenth century (Hounshell, 1984). As the Brooklands episode suggests, interchangeable parts create a more modular design: parts can be swapped in and out. At the same time, however, standardization eliminates one form of ‘loose coupling’ possible in crafts production.²¹ Variation in the components becomes increasingly intolerable. In the classic form of mass production, so does variation in the final product. Moreover, mass production requires operatives (including, eventually, machines) to carry out an unambiguous sequence of steps—a computer program, in effect. Thus the design of the overall production process becomes more highly structured, while discretion and variation are eliminated from the individual stages, a process that unsympathetic scholars have labeled ‘deskilling’ (Marglin, 1974) and ‘Fordism’ (Sabel, 1982).

One important implication of this is that standardization and high throughput do not eliminate the need to buffer uncertainty; indeed, they make it all the more urgent—for any variation that finds its way into a high-throughput system can bring production to a crashing halt. What buffers uncertainty in Chandlerian managerial capitalism is exactly what buffers uncertainty in crafts production or non-specialized merchandising: the information-processing ability of human managers. Because of the new high-throughput structure of production, however, that buffering is no longer distributed to the individual stages of production—from which standardization has eliminated variation—but has effectively moved ‘up the hierarchy’ to the managers who control the work flow (Stinchcombe, 1990: 64).²²

Professional management is specialization in one sense: the manager is manager only and not in any important way a capitalist or anything else. But, like the merchant of yore, the manager is also a generalist: the manager is skilled in general techniques of management independent of any specific firm or industry. The non-specific training of managers was abetted in the twentieth century by the rise of the business school, which, like other professional schools emerging at the same time, equipped its students with a standardized ‘toolkit’ (Langlois and Savage, 2001). This should not be surprising.

²⁰For this feat Leland was awarded the Dewar Trophy as winner of the first Standardization Test of the Royal Automobile Club. Cadillac’s British operation had in fact instigated the competition as a publicity stunt, and Cadillac was the only contestant; but Cadillac was also the only manufacturer capable of the precise machining tolerances necessary to pass the test (Leland and Millbrook, 1966: ch. 1).

²¹Contrary to what is sometimes said in the literature on modular product design, modularity does not imply loose coupling, nor does non-modularity imply tight coupling.

²²Top managers will not be the only buffers, of course. They will be aided by a large number of discretionary workers at multiple levels. ‘There will generally be a separate set of skilled manual work departments (maintenance, tool and die making, and special departments that vary with the technology, such as the crew who lay firebricks inside steel furnaces) and skilled staff workers at the managerial levels (engineering, quality control and inspection, scheduling and inventory), besides the whole routinized structure of the production line and the ‘line’ supervisory structure that keeps it running’ (Stinchcombe, 1990: 64).

Chandlerian managers are generalists for the same reason that crafts artisans and merchants are generalists: because their function is to buffer uncertainty. They need a wide range of skills that can be applied flexibly in response to an unpredictable array of concrete circumstances.

5. From scale to scope: the corporate century

In setting up managerial structures to buffer high-throughput production, the large corporations of the late nineteenth century created something more: a system of *organizational capabilities*.²³ Geared initially toward the management of scale, these organizational capabilities soon enabled corporations to expand their scope. In Chandler's words, they

. . . provided an internal dynamic for the continuing growth of the enterprise. In particular, they stimulated its owners and managers to expand into more distant markets in their own country and then to become multinational by moving abroad. They also encouraged the firm to diversify by developing products competitive in markets other than the original one and so to become multiproduct enterprises. (Chandler, 1990: 8–9)

As Edith Penrose (1959) had suggested, this is an important mechanism by which firms grow. In her theory, firms consist of bundles of 'resources,' including the managerial resources that Chandler and others call capabilities. Resources are often lumpy, and some are therefore in excess capacity. This means that organizational capabilities developed in one area can spill over to new tasks at low marginal cost. Indeed, economies of scale and scope are ultimately made of the same stuff: they both involve the reuse of a structure of knowledge, in one case to stamp out more of the same product, in the other case to produce something different that requires similar knowledge (Langlois, 1999b).

Especially early on, diversification was a matter of taking advantage of byproducts—the classic economies of scope of the textbook. For example, Armour, Swift, and other meatpackers sold fertilizer, leather, glue, soap and other items made from the byproducts of the slaughterhouse (Chandler, 1990: 168). Significantly, firms diversified in a modular way by creating for the various products new organizational units that could be dropped into the overall corporate structure. By the twentieth century, however, diversification came to flow more from reusable facilities, knowledge and business practices. For instance, Swift and his competitors began to distribute butter, eggs, poultry and fruit using the distribution system originally set up for meat (Chandler, 1990: 168). Notice that in moving from scale to scope, corporations became generalists to a greater extent, thus reversing the original trend toward product-oriented specialization—and away from generalist merchants—that had created those

²³G. B. Richardson (1972: 888), who coined the term, called capabilities the 'knowledge experience, and skill' of the organization. For further discussion of this idea, see Langlois and Robertson (1995: ch. 2).

corporations in the first place. I will suggest soon that the vanishing hand can be understood in part as a continuation of this process of the broadening of capabilities and their decoupling from specific products.

For most of the twentieth century, of course, the process of capability-building that Chandler describes did not challenge the structure of vertically integrated managerial capitalism. Indeed, it reinforced it. As Chandler (1997: 64) notes, after the Second World War especially, ‘the essential large-scale investments in both tangible and intangible capital were made not by new enterprises as they had been in the past, but primarily by well-established firms whose existing learned organizational capabilities were critical in developing and commercializing the potential the new technologies on a global scale’. The large corporations were recreating significant parts of the US value chain along new lines, which led them to grow internally in the path-dependent way implied by Penrose’s theory.

Such growth placed increasing strain on corporate buffering mechanisms. In part, the firms responded by decentralizing divisions, a kind of buffering in emulation of the market.²⁴ But, as Herbert Simon pointed out, buffering mechanisms, which help an organization respond better to variation, are not the only way to attack the problem of environmental uncertainty:

If we want an organism or mechanism to behave effectively in a complex and changing environment, we can design into it adaptive mechanisms that allow it to respond flexibly to the demands the environment places on it. Alternatively, we can try to simplify and stabilize the environment. We can adapt organism to environment or environment to organism.

(Simon, 1960: 33)

In the first century of the managerial revolution, large firms did indeed seek to simplify and stabilize their environments—a phenomenon that has absorbed the ink of legions of economists and pundits over the years.

One class of such attempts falls within the broad purview of antitrust. That Chandler’s large corporations have typically been discussed—and for long periods exclusively discussed—from the perspective of trustification and monopoly is a story too tedious to tell here, and perhaps too trite to be worth telling. Virtually alone among writers on the subject, Joseph Schumpeter argued that behavior derided as restrictive or ‘anticompetitive’ actually can serve the function of controlling environmental uncertainty in a way that facilitates high-throughput production—and thus increases rather than decreases output.

Practically any investment entails, as a necessary complement of entrepreneurial action, certain safeguarding activities such as insuring or

²⁴Although the transformation from functional to product organizations [the M-form] has usually been justified as a means to enhance control and coordination (Chandler, 1962), it also is a way of segregating experience’ (Levinthal and March, 1993: 98).

hedging. Long-range investing under rapidly changing conditions, especially under conditions that change or may change at any moment under the impact of new commodities and technologies, is like shooting at a target that is not only indistinct but moving—and moving jerkily at that. Hence it becomes necessary to resort to such protecting devices as patents or temporary secrecy of processes or, in some cases, long-period contracts secured in advance. But these protecting devices which most economists accept as normal elements of rational management are only special cases of a larger class comprising many others which most economists condemn although they do not differ fundamentally from the recognized ones.

(Schumpeter, 1950: 88)

Schumpeter also had a more colorful term for what I have blandly called environmental variation or uncertainty: ‘the perennial gale of creative destruction’ (Schumpeter, 1950: 84).

Notice that Schumpeter sees the corporation’s ‘safeguarding activities’ as akin to buffering techniques like insuring and hedging. Let me focus on a couple of ‘protecting devices’ that will be of significance down the road. Chandler has long maintained that, in effect, vertical integration is itself a mechanism for controlling the environment—by putting large parts of that environment under the influence of managerial buffering. But within the vertically integrated structure, the stages of production with high fixed cost play a special role. Industrial organization economists have laid great stress on the role of sunk costs in deterring competitive entry and generally slowing the competitive environment (Baumol, 1982; Sutton, 1991). Fixed costs are not always sunk costs, of course; but they tend to become so when markets for the fixed assets are thin, as will be the case when those and comparable assets are isolated within the internal production of vertically integrated firms. This is relevant to my story: for when markets become thicker, the ‘sunk’ character of assets diminishes, which reduces the benefits of vertical integration.

In some lines of business, vertical integration also threw up transaction-cost problems of a more traditional sort. This was especially true in consumer goods but also in some kinds of producer goods as well. In the days of generalist wholesalers and retailers, merchants were not only purveyors of goods but also guarantors of quality. Soap, flour, butter were undifferentiated products in whose quality the customer trusted because he or she trusted the retailer, whose good name served as a kind of bond. As high-speed continuous-process technology made it dramatically more economical for the producer rather than the wholesaler or retailer to package commodities (Chandler, 1977: 289ff.), the role of these latter in guaranteeing quality all but vanished. In principle, this meant that the costs to consumers of verifying quality would increase, perhaps dramatically. The solution to the problem, of course, was branding, which allowed the producer to speak, as it were, directly to the consumer and to utilize some of the same bonding mechanisms that the local grocer had once used (Klein and Leffler,

1981).²⁵ New generalist retailers like Sears and A&P also sprang up to carry a wide variety of branded products, and these were able to add the bonding power of their own names to that of the individual product brands, sometimes even selling the commodities under their own house brand (Kim, 2001). In addition, the large multi-unit retailers were able to create capabilities, and to exploit scale economies, in quality management and assurance.

Branding did more than solve a transaction-cost problem, of course. It was another method of attempting to control the environment in order to reduce variation and uncertainty. This is clear even from a standard neoclassical textbook. By creating a product differentiated in the eyes of the consumer, a firm can enjoy a more inelastic demand curve, which damps fluctuations in price and quantity. And branding is what makes product differentiation possible. Even if quality is the brand's only distinguishing characteristic—as was arguably the case for commodities like branded gasoline—branding will still have this damping effect (Klein and Leffler, 1981).

All of these methods of attempting to control the environment pale in comparison with getting the government involved. Economists and political scientists have long since come around to the idea that regulation is something that firms and industries often work hard to bring upon themselves (Kolko, 1963; Stigler, 1971). Politicians are often anxious to supply regulation, as it earns them the political support they crave. And firms are equally anxious demanders of regulation, as it serves their interests. Those interests are normally understood in terms of increased profits from government-managed cartelization and restrictions on competitive entry. But clearly government can also serve a damping function.²⁶ It provides an environment alternative to, or at least supplementary to, the market—an environment that is either inherently less variable or that can be more easily dealt with by the buffering mechanisms of management. Of course, not all industries fit this picture: it is doubtful that regulation of

²⁵It is not correct to say, however, as Kim (2001) seems to imply, that the system of branded products supplanted the earlier system because of its superior transaction-cost properties. In Kim's story, products became more sophisticated because of technological change, making it harder for consumers to judge quality directly. This gave the advantage to big chain stores, which had large amounts of capital with which to bond quality. As Chandler shows, however, the principal innovations in this period were in the nature of process technology. Soap, beans, butter, cigarettes, etc., did not change much—but they could be packaged much more quickly by machine. Moreover, even in the early nineteenth century, consumers could not directly discern the quality of products by casual inspection: many of the most famous cases of adulteration involved simple commodities like bread or flour. And small generalist retailers were often perfectly capable of certifying the weight and purity of even sophisticated commodities like pharmaceuticals; only now are pharmacists being supplanted by branding, and that is because of a change in the sophistication of testing equipment as much as by changes in the drugs themselves (Savage, 1994). In the end, the system of branding arose to solve a transaction cost problem caused by—but that was arguably small in comparison with—the major production-cost gains from new process technology. Whether branding is superior to local certification and bonding on purely transaction-cost grounds is an open question.

²⁶Government may also be enlisted to serve the quality guaranteeing function alluded to earlier. A classic example of this is the institution of federal inspection of meat (Libecap, 1992).

taxicabs in major cities or of interstate trucks under the old regime of the Interstate Commerce Commission had much to do with buffering in a world of high fixed costs. But many other industries, often supposed 'natural monopolies' in undifferentiated products like electricity, telephone services or natural gas transmission, may have sought regulation in part to help control a complex, internally managed production system containing critical components with high fixed costs.²⁷ Even in industries not directly regulated by agencies, government action often came in handy as 'safeguarding activities' to buffer demand shocks or to provide a cushion of economic rents.

Although the problems of buffering high-throughput production have not made much impression on the mainstream literature on government and business, there is a line of thought along the fringes that takes this problem as central. Running roughly from Thorstein Veblen (1921) to Williamazon (1991), this literature sees it as crucial that managers be insulated from the vagaries of the environment, especially those caused by financial and other markets. Veblen considered financial markets 'industrial sabotage'. The most eloquent voice in this tradition belonged, however, to John Kenneth Galbraith, whose *New Industrial State* distilled through hyperbole the essence of the corporate century he could see stretching behind him in 1967. Galbraith takes it for granted that technological change always leads to greater complexity and scale. This complexity and scale requires 'planning'; such is the imperative of technology, an imperative that can only grow stronger in the future. Planning means not only the attempt to foresee and prepare for future contingencies but also the removal of transactions from the market to the realm of managerial authority.

If, with advancing technology and associated specialization, the market becomes increasingly unreliable, industrial planning will become increasingly impossible unless the market also gives way to planning. Much of what the firm regards as planning consists in minimizing or getting rid of market influences.²⁸ (Galbraith, 1971: 42–43)

It is perhaps a fitting reward for the hubris this view of planning implies that the not-too-distant future had in store a picture of technology and organization that would be virtually the diametric opposite of the one Galbraith painted.

²⁷I do not mean this to suggest that such regulation is therefore obviously desirable. Although regulation may indeed serve the function of smoothing the environment, and thus of helping a highly integrated structure to make good use of its high-throughput assets, it also has the effect of freezing the environment and of insulating the organization from the changing configuration of relative scarcities and transaction costs in the economy. Without regulation, firms have to control variation by making themselves more adaptable, which may be a better long-run outcome. At the end of the twentieth century, as we will see presently, even regulation could not protect firms from the need to adapt their structures.

²⁸The syllogism continues, of course. Since a little planning is good, a lot must surely be better. So the government should largely replace the market system with central planning.

6. From internal to external capabilities: the new economy.

Ruttan and Hayami (1984) have proposed a theory of institutional change that is relevant to my story of organizational-and-institutional change. As they see it, changes in relative scarcities, typically driven by changes in technology, create a demand for institutional change by dangling new sources of economic rent before the eyes of potential institutional innovators. Whether change occurs will depend on whether those in a position to generate it—or to block it—can be suitably persuaded. Since persuasion typically involves the direct or indirect sharing of the available rents, the probability of change increases as the rents increase. And the more an institutional or organization system becomes misaligned with economic realities, the more the rents of realignment increase.

By the 1980s, the large corporation that had looked inevitable and invincible in the 1950s and 1960s had become an organizational structure increasingly misaligned with economic realities—and an organization in the process of redefining itself. Quite apart from any mechanisms of environmental control they may have themselves created, the large US corporations after the Second World War benefited from the attenuated climate of competition that came with the destruction of the German, Japanese and other economies. As those economies revived and trade began expanding by the 1970s, the easy life was coming to an end. Indeed, by the 1980s and 1990s, the image of invincibility had been virtually replaced by its opposite. As Mark Roe notes, ‘the image of the corporation as a sweating and not-always-successful competitor has become more vivid’ (Roe, 1996: 106).

The US corporation’s mechanisms of environmental control and its charmed life in the 1950s and 1960s had permitted it largely to ignore ongoing changes in the scale of technology as well as the increasing thickness and realignment of markets. In startling contrast to Galbraith’s (rather nineteenth-century) view of technological change, innovation often—and perhaps mostly—proceeds by simplifying and by reducing scale.²⁹ Arguably, this has been the dominant trend of the twentieth century.³⁰ For example, in electricity generation, among the most scale-intensive of fields, the development of aero-derivative combined-cycle generating technology (CCGT) has significantly reduced the minimum efficient scale of new electric capacity (Joskow,

²⁹This seems to have been Adam Smith’s (eighteenth-century) view. What drives innovation is the desire to perform a given set of operations more elegantly and economically (Smith, 1976: I.1.8).

³⁰I mean this as a long-run proposition. In the short run, innovation can certainly increase scale. Moreover, the effect of technological change on scale is sometimes subtle, in that scale reduction in one part of the system can lead to increased scale elsewhere. The advent of the small electric motor (eventually) led to the demise of highly centralized steam power in factories (David, 1990); but it also increased the extent of the market for electric power and (initially at least) helped increase the scale of its generation. Indeed, in some cases, the Internet and FedEx have clearly had the same scale-increasing effect as the telegraph and the railroad: think of Amazon.com. But over time, holding all else constant, the scale of a given technology tends to decline. (On this point, see also Langlois, 1999a: 56.)

1997: 123). In telephony, the rise of semiconductor technology in general and the development of the private branch exchange (PBX) in particular turned switching from a centralized to a decentralized-network technology (Vietor, 1994: 188). At the same time, rising populations, rising income and newly vibrant international trade generated thicker markets. This meant, among other things, that, even where technology was not threatening to reduce scale, existing structures of fixed cost shrank relative to the extent of the market. For example, by the time CCGT had arrived, increases in market size had long since stripped electric power generation of its natural-monopoly character (Joskow and Schmalensee, 1983).

My argument is that these changes in technology and markets opened up attractive rent-seeking possibilities that could be seized only by breaking down or ‘unbundling’ the vertical structure of the managerial corporation. This is perhaps clearest in what most had long considered the intractable cases of vertical integration: regulated utilities. We need only think of long-distance telephony, in which a scale-reducing technical change—microwave transmission, in this case—created opportunities for whoever could open up AT&T’s legal hold on the field.³¹ Entrepreneur William McGowan of MCI poured resources first into persuading the Federal Communications Commission to alter its policies and then into fomenting the breakup of AT&T (Temin, 1987). Similar tales can be told for the deregulation of electricity (Kench, 2000) and other industries. A similar process of unbundling is also underway in less-regulated industries, where the impediments to supplying organizational change are substantially lower though not necessarily absent.

In some respects, the internal dynamic of scale and scope that Chandler chronicles contributed in an almost Hegelian fashion to the corporation’s own undoing. Driven by the Chandler–Penrose imperative to apply existing managerial skills and other capabilities more widely, the corporation in the 1960s took the idea of diversification to new levels.³² ITT was the paradigm. Originally an international supplier of telephone switching equipment, it bought, among other things, an insurance company, a hotel chain and the maker of Hostess Twinkies. In assembling conglomerates, as Mark Roe (1996: 113) argues, ‘managers learned that they could move subsidiaries and divisions around like pieces on a chessboard’.

Conglomerates were assembled from separate firms, with a central headquarters directing the firm. Their widespread use in the 1960s taught managers that it was possible to mix and match corporate divisions. It was

³¹In this case, the possibilities arose in part because of AT&T’s pricing structure, which for political reasons had subsidized local service at the expense of long distance—a misalignment with relative scarcities made possible by AT&T’s status as a regulated monopoly (Vietor, 1994: 183).

³²Of course, there were institutional factors as well. Roe (1996) points to the favorable tax treatment of retained earnings relative to dividends. Shleifer and Vishny (1991) argue that stringent antitrust policy in the 1960s discouraged cash-rich firms from acquiring companies in related industries, forcing them into unrelated diversification.

only a small leap of an organizational idea for a conglomerate to bring in an outside firm via a hostile acquisition by buying up the target's stock and tucking the formerly independent firm in as one now managed from the conglomerate headquarters. From there it was only another small mental jump in the 1980s to understand that once the pieces of a conglomerate had been assembled, they could be disassembled as well. (Roe, 1996: 114)

Notice also that the managers could move divisions around like pieces on a chessboard in the first instance because of the modular structure of the M-form.

Aided by innovations in the securities markets, the leveraged-buyout wave of the 1980s disassembled the conglomerate of the 1960s. 'By and large', write Bhagat *et al.* (1990: 2), 'hostile takeovers represent the deconglomeration of American business and a return to corporate specialization.' Indeed, specialization became the strategic catchword of the 1990s. Whereas the most influential text on corporate strategy in 1980, that of Michael Porter (1980), had counseled its readers to profit through buffering mechanisms and the control of the environment, the leading gurus of the next decade taught that the keys to success lay within and that firms could prosper only by returning to their *core competences* (Prahalad and Hamel, 1990). Shoemaker, stick to your last.

What has been less well observed, however, is that the changes of the 1980s did not amount to a return to the pre-conglomerate days of the 1950s, to the 'modern corporation' that Chandler had described. Something fundamental had changed. If a corporation—even a non-conglomerated one—is an amalgam of division-modules, then the logical extension of the idea of corporate specialization would be to hive off not only unrelated divisions but also vertically related divisions as well. As Richardson (1972) pointed out, it is highly unlikely that the various vertical stages of a production process should all call for similar kinds of capabilities.

And this is what has happened. 'Even a cursory examination of the industrial system of the United States in the 1990s reveals organizational patterns that look not at all like the modern corporation', writes Timothy Sturgeon.

The largest single employer in the country is not General Motors, but a temporary employment agency called Manpower Inc. The largest owner of passenger jets is not United Airlines, or any other major carrier, but the aircraft leasing arm of General Electric. American automakers have spun-off their in-house parts subsidiaries and outsourced the design and manufacture of entire automotive sub-systems to first-tier suppliers. Since 1992, IBM has literally turned itself inside-out, becoming a merchant provider of the basic components it had previously guarded so jealously for exclusive use in its own products. If what we see today seems to have little relation to the ideal type of the modern corporation, there may be good reason. Perhaps the American industrial system has begun to adapt to the new, more intense global competitive environment that triggered the competitive crisis in the first place. Perhaps we are witnessing the rise of a

new American model of industrial organization, and not simply the resurgence of the old. (Sturgeon, 2002: 454)

In many respects, the structure of this new model looks more like that of the antebellum era than like that of the era of managerial capitalism. Production takes place in numerous distinct firms, whose outputs are coordinated through market exchange broadly understood. It is in this sense that the visible hand of management is disappearing. Unlike the antebellum structure, however, the new economy is a high-throughput system, with flows of work even more closely coordinated than in a classic Chandlerian hierarchy.

Vertical disintegration and specialization is perhaps the most significant organizational development of the 1990s. My goal is to explain this development not to document it. But the evidence is clear. Measuring vertical integration is never easy; but, using trade-flow data, international economists have found that the

. . . rising integration of world markets has brought with it a disintegration of the production process. . . . Companies are now finding it profitable to outsource increasing amounts of the production process, a process which can happen either domestically or abroad. This represents a breakdown in the vertically-integrated mode of production—the so-called ‘Fordist’ production, exemplified by the automobile industry—on which American manufacturing was built. (Feenstra, 1998: 31)

Using Canadian census data, Baldwin *et al.* (2002) found that Canadian firms have increased plant and firm specialization in secular fashion as the extent of the market has grown, with increases in commodity specialization accelerating after 1988 as a result of the North American Free Trade Agreement.

The anecdotal evidence is equally compelling. In electronics, firms like Sanmina-SCI, Solectron and Flextronics specialize in assembling on contract electronic systems of all sorts (Sturgeon, 2002). But they neither design³³ nor distribute nor market the systems themselves. Indeed, in early 2002, IBM—the originator of the dominant personal computer standard—sold its entire domestic assembly operations to Sanmina-SCI (Bulkeley, 2002). In pharmaceuticals, the major integrated companies are increasingly outsourcing manufacturing and marketing to firms like DSM and clinical trials to contract research firms like Quintiles Transnational and Covance (Dolan and Meredith, 2001). A major new trend in semiconductor manufacturing has been the rise of so-called fabless semiconductor firms. These firms retain design, development and marketing functions but do not own their own manufacturing plants (called ‘fabs’ in

³³More correctly, they do not *brand* their own systems. These firms will often supply design and engineering services when asked. For example, Flextronics and Solectron not only manufactured the Handspring Visor but were also involved in its design in order to smooth manufacturing and quicken time to market (Dolan and Meredith, 2001). On the other hand, design services are a specialty that can also be purchased on the market. Ideo, a specialist design firm, is responsible for another Handspring model, the Visor Edge.

industry argot); instead, they contract out the actual manufacture of the chips to specialized 'silicon foundries' (Langlois and Steinmueller, 1999: 51). Led by Chrysler in the 1990s, US automobile manufacturers began to modularize their product design and supply chain strategies and to rely more heavily on subcontractors (Fine, 1998: 61–62). The American Big Three automakers spun off individual parts units like Delphi and Visteon, and in 2000 they and several other car-makers formed an electronic business-to-business supplier network called Covisint. If Gustavus Swift were looking to ship ice reliably today, he could call on any number of third-party logistics suppliers like Bax Global, Menlo Worldwide or Ryder. The litany could continue.

This is specialization, of course. But notice also that these subcontractors are also generalists. Flextronics will put together virtually any kind of electronic device you ask it to; DSM will produce whatever drug you hand it; and the silicon foundries of Taiwan (and elsewhere) will manufacture whatever chip design you send them electronically. In the auto industry, parts suppliers are generalizing their capabilities across major subsystems (Fine, 1998: 65).

This coupling of specialization of function with generalization of capabilities recalls the generalist merchants of the early republic.³⁴ It is in fact a typical feature of the Smithian process. In his famous analysis of that process, George Stigler (1951: 192) referred to what he called 'general specialties'. He had in mind activities like railroads, shipping and banking that can benefit a variety of industries; but contract suppliers are clearly examples in the small—microcosmic instances of what economists now call *general-purpose technologies* (Helpman, 1998). This trend toward general specialties is a continuation of the process of decoupling capabilities from products that Chandler observed in *Scale and Scope*. It is also a mechanism by which the market system buffers uncertainty. Since a general specialist is not tied to a particular product or brand, but takes in work from many purveyors of products and brands, it can diversify its portfolio more effectively. This smoothes demand and facilitates high-throughput production.

Among the most important general-purpose technologies are social institutions. Just as decentralization of the stages of production depends on the extent of the market, so the extent of the market depends on institutions that support specialization and exchange. Secure and alienable property rights are one example, but there are more specific institutions at work in particular markets. Many of these take the form of standards. Decentralization implies an ability to cut apart the stages of production cleanly enough that they can be placed into separate hands without high costs of coordination; that is to say, decentralization implies some degree of standardization of 'interfaces' between stages. In an extreme—but far from rare—case, standardized interfaces can turn a product into a modular system (Langlois and Robertson, 1992).

Just as did the high-throughput technologies of classical mass production, modular systems require and arise out of standardization. But unlike classical mass-production technologies, which standardize the products or processes themselves, modular systems

³⁴Not to mention Chandlerian managers, who specialized in management but possessed general management capabilities.

standardize something more abstract: the rules of the game, or what Baldwin and Clark (2000) call *visible design rules*. So long as they adhere to these rules, participants need not communicate the details of their own activities, which become *hidden design parameters*. By taking standardization to a more abstract level, modularity reduces the need for management and integration to buffer uncertainty. One way in which it does so is simply by reducing the amount of product standardization necessary to achieve high throughput. This is the much-remarked-upon phenomenon of mass customization (Cox and Alm, 1998). For example, the highly modular structure of the personal computer as it developed during the 1970s and 1980s (Langlois, 1992a) made it possible for Michael Dell and others to begin selling PCs to order by assembling them like Lego from a set of standardized components (Kraemer and Dedrick, 2001). In so doing, PC makers could blanket more fully what economists call the product space (Langlois and Robertson, 1992); that is, they could fine-tune products more closely to the needs of individual users. When economies of scale no longer require largely identical products to be manufactured *en masse* on spec, a major source of environmental uncertainty disappears, and with it the need to buffer that uncertainty.³⁵

When a modular product is embedded in a decentralized production network, benefits also appear on the supply side³⁶ (Langlois and Robertson, 1992). For one thing, a modular system opens the technology up to a much wider set of capabilities. Rather than being limited to the internal capabilities of even the most capable Chandlerian corporation, a modular system can benefit from the *external capabilities* of the entire economy. External capabilities are an important aspect of the 'extent of the market', which encompasses not only the number of possible traders but also the cumulative skill, experience and technology available to participants in the market. Moreover, because it can generate *economies of substitution* (Garud and Kumaraswamy, 1995) or *external economies of scope* (Langlois and Robertson, 1995), a modular system is not limited by the weakest link in the chain of corporate capabilities but can avail itself of the best modules the wider market has to offer. In addition, an open modular system can spur innovation, since, in allowing many more entry points for new ideas, it can create what Nelson and Winter (1977) call rapid trial-and-error learning.³⁷ From the perspective of the present argument, however, the crucial supply-side benefit of a modular production network is that it provides an additional mechanism of buffering.

³⁵Lamoreaux *et al.* (2002) make a similar point from the demand side. As incomes rose in the USA after the Second World War, consumers became less satisfied with undifferentiated products, creating a disadvantage for the large Chandlerian firm and an advantage for smaller, more flexible units.

³⁶The supply-side aspect of modular standards have gone largely unnoticed in the economics literature, which has focused almost exclusively on the possibilities of demand-side network effects.

³⁷Baldwin and Clark (2000) have recently explicated this last point in the language of finance theory. If we think of each experiment taking place in the system as a *real option*, then an open modular system can create more value than a closed corporation even if the same number of experiments takes place in each system. This is a consequence of the theorem in finance that says that a portfolio of options (the modular system) is worth more than an option on a portfolio (the experiments within the corporation).

Social institutions, including standards, can support specialization and exchange in other ways. When we think of markets becoming ‘thicker’, we think of more traders for existing commodities. But liquidity is also a matter of having markets in the first place. To put it another way, the development of markets is often and importantly about the creation of new tradable units. Sometimes these are ‘new products’ in a conventional sense: the hula-hoop or Beanie Babies. But often the new products around which markets develop are pieces of some larger system that become standardized and get broken off for arm’s-length trade. For example, markets for spare parts blossomed in the 1920s as the aging of the automobile fleet encouraged a multitude of third-party manufacturers (Langlois and Robertson, 1989: 369). At a deeper level, what made this possible was the standardization of the automobile into a ‘dominant design’, thereby reducing qualitative variation in the list of parts. Even though designs and parts change from year to year, a fleet of cars once on the road is effectively a modular system, many of whose modules are standard enough to trade on markets.

Consider a more recent example (Jacobides, 2002). Traditionally, the stages of home mortgage lending—originating, underwriting, holding and servicing the loan—were integrated within banks and savings-and-loan associations. Vertical control allowed bankers to buffer the default and other risks in the face of asymmetric information and potential moral hazard. In the 1970s, however, the government-sponsored Federal National Mortgage Association (Fannie-Mae) created, for reasons of its own, a mortgage portfolio security that could be traded on financial markets. Originally, the full faith and credit of the US government helped solve the resultant agency problems; but soon standards emerged for quality sorting, and the use of markets spread to other quasi-governmental corporations and then to fully private financial firms. Now the various stages of the mortgage process are typically undertaken by different organizations.

Although modularity in a deep sense lies behind all decentralization (Langlois, 2002), I do not want to be understood as saying that the Chandlerian corporation is giving way to pure modular systems and anonymous arm’s-length markets. In many cases, the visible hand has indeed been socialized into technical standards³⁸ that permit external mechanisms of coordination and reduce the need for rich information transfer. In many other cases, however, products will continue to maintain significant ‘integrality’, and relationships between stages will often be collaborative ones involving trust, permanence, and the transfer of rich information (Helper *et al.*, 2000). Although the personal computer is the epitome of a modular system, market leader Dell exercises considerable administrative control over stages of production it does not own—effectively creating through the market the kind of tightly integrated logistics system Swift had created through a Chandlerian corporation (Fields, 2003). As a central tendency, however, the buffering functions of management are devolving to the mechanisms of modularity and the market—informational decomposition, flexibility, and risk spreading.

³⁸I am indebted to Martin Kenney for this phrase.

7. Transaction costs and the new economy

The reader may have noticed that the Internet and other present-day technologies of coordination have played at best a supporting role in my story rather than a starring role. This is somewhat in contrast to the billing technology has received in other venues. In the year 2000, the *New York Times* offered up Ronald Coase as the indisputable if improbable guru of Internet economics (Tedeschi, 2000). In his famous 1937 paper, Coase had argued that transaction costs drive the make-or-buy decision; thus, since the Internet has reduced transaction costs, Coase had effectively predicted a principal feature of the New Economy: the increasing devolution of transactions from firms to markets. Of course, what Coase actually said is that the scope of the firm is determined in Marshallian fashion at the margin: the firm will expand (in terms of number of activities internalized) until the costs of internalizing one more transaction just balance the costs of an equivalent transaction on the market. And, as Hal Varian reminds us in a more recent *New York Times* article (Varian, 2002), the effects on market structure of information-improving innovation are thus ambiguous: they depend on whether the innovation reduces the costs of organizing internally more than it reduces the costs of organizing on markets. Just remember, says Varian, the railroad and the telegraph gave us the large vertically integrated firms of the nineteenth century.

Malone and Laubacher (1998: 147) take this point one step further. Until recently, they contend, virtually all improvements in the technology of coordination favored internal organization. ‘The coordination technologies of the industrial era—the train and the telegraph, the automobile and the telephone, the mainframe computer—made internal transactions not only possible but advantageous.’ It is only with the very recent development of even more powerful coordination technology—personal computers and broadband communication networks—that markets have been favored. ‘Because information can be shared instantly and inexpensively among many people in many locations, the value of centralized decision making and expensive bureaucracies decreases’ (*ibid.*).

This may well be part of the story. But the hypothesis I offer here is a bit more subtle, or at least a bit more complicated, and arguably more general. In my view, the phenomenon of the vanishing hand is a further continuation of the Smithian process of the division of labor on which Chandler’s managerial revolution was a way-station.³⁹ Thus the vanishing hand is driven not just by changes in coordination technology but also by changes in the extent of markets—by increasing population and income, but also by the globalization of markets. Reductions of political barriers to trade around the world are having an effect analogous to the reduction of technological barriers to trade in the United States of the nineteenth century (Findlay and O’Rourke, 2002). Is this a

³⁹Note that Smith’s theory is not a historicist prediction but rather a contingent causal theory: the division of labor is caused or enabled by the extent of the market, all other things equal. This is a potentially reversible process, as when specialization in Europe declined after the fall of the Roman Empire.

revolution or the continuation of a long-standing trend? Again, the answer depends on one's perspective. My argument is that, just as the US 'globalization' after the Civil War was revolutionary in its systemic reorganization of production toward standardization and volume, the new era is revolutionary in its systematic deverticalization in response both to changes in coordination technology and to plain-old increases in the extent of markets.

Indeed, it is not clear that we are entitled to see coordination technology as an entirely exogenous influence on organization form. Perhaps we might grant the deployment of the telegraph as an exogenous event that helped to integrate markets and thus helped bring about the managerial revolution. But when we think of much of the rest of the technology employed by managerial organizations—from filing cabinets to carbon paper to typewriters to mimeograph machines (Yates, 2000)—we might more usefully think in terms of the coevolution of technology and organization. Physical and social technologies⁴⁰ influence one another by each throwing up problems the other is challenged to solve. On the one hand, this reinforces the notion that an organizational structure biases technological change in ways that reinforce that structure. On the other hand, it reduces the extent to which we can view such technological change as independently causative. Was the Internet an exogenous event like the telegraph that altered organizational form decisively? Perhaps. But it is well to remember that, back when the currency of the digital world was dots and dashes rather than zeroes and ones, the international hub of e-commerce was Manchester, England, where the telegraph served as a vibrant element in one of history's most vertically disintegrated production systems—the British cotton textile industry (Farnie, 1979: 64). In my view, the relationship among coordination technology, transaction costs and industrial structure remains an open research agenda.

Figure 1 summarizes the vanishing-hand thesis in visual form. I have called the independent variable 'thickness of markets', which is driven by exogenous factors like population, income, and the height of technological and political trade barriers. The vertical axis is called 'urgency of buffering', by which I mean to capture the degree to which the technology of production is complex, sequential and high-throughput. Producing cotton cloth under the putting-out system would have a low degree of urgency of buffering; producing electricity for the state of California would have a high degree of urgency of buffering. The straight line moving northeast from the vertical axis represents the boundary between firm and market. Above the line, buffering through integration and management is less costly; below the line, buffering through markets (of a thickness given on the horizontal axis) is preferable. That the line slopes upward simply reflects the increased ability of markets to buffer product-flow uncertainty as they thicken.

The more-or-less parabolic curve superimposed on this space represents the vanishing-hand hypothesis. Think of it as a path in time, rather like the plot of an

⁴⁰To use the language of Nelson and Sampat (2001). Their point is that institutions—including generic organizational forms—evolve in much the same way that technology does.

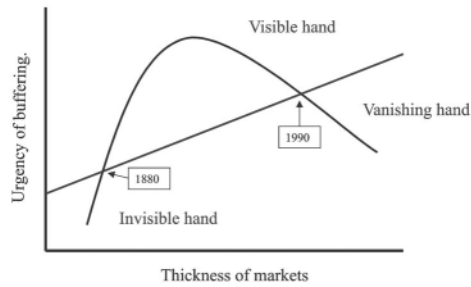


Figure 1 The vanishing-hand hypothesis.

explorer's progress on a map.⁴¹ The possibilities for high-throughput technologies and mass production made possible in the late nineteenth century generated a rapid and sudden increase in the urgency of buffering. This is reflected in the initially steep slope of the curve: markets were insufficiently thick to buffer product-flow uncertainty, just as they were initially too underdeveloped to handle financial risk. Over time, two things happen: (i) markets get thicker, and (ii) the urgency of buffering levels off and then begins to decline. In part, urgency of buffering declines because technological change begins to lower the minimum efficient scale of production. But it also declines because improvements in coordination technology—whether applied within a firm or across firms—lower the cost (and therefore the urgency) of buffering.

More or less arbitrarily, I have labeled as 1880 the point at which the path crosses the firm-market boundary. This is the start of the Chandlerian revolution. Equally arbitrarily, I label as 1990 the point at which the path crosses back. This is the vanishing hand. Far from being a general historical trend, the managerial revolution—in this interpretation—is a temporary episode that arose in a particular era as the result of uneven development in the Smithian process of the division of labor.

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⁴¹The technically inclined may want to view it as the projection onto two dimensions of a curve in three-dimensional space, with the third (z) dimension being time.

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